

# Simultaneous Localization and Mapping for Planetary Surface Mobility, Phase I

Completed Technology Project (2011 - 2012)



## Project Introduction

ProtoInnovations, LLC and Carnegie Mellon University have formed a partnership to commercially develop localization and mapping technologies for planetary rovers. Our first aim is to provide a reliable means of localization that is independent of infrastructure, such as GPS, and compatible with requirements of missions to planetary surfaces. Simultaneously solving for the precise location of the rover as it moves while building an accurate map of the environment is an optimization problem involving internal sensing, sensing of the surrounding environment, probabilistic optimization methods, efficient data structures, and a robust implementation. Our second aim is to merge simultaneous localization and mapping (SLAM) technologies with our existing Reliable Autonomous Surface Mobility (RASM) architecture for rover navigation. Our unique partnership brings together state-of-the-art technologies for SLAM with experience in delivering and supporting both autonomous systems and mobility platforms for NASA. Our proposed project will create a SLAM framework that is capable of accurately localizing a rover throughout long, multi-kilometer traverses of barren terrain. Our approach is compatible with limited communication and computing resources expected for missions to planetary surfaces. Our technology is based on innovative representations of evidence grids, particle-filter algorithms that operate on range data rather than explicit features, and strategies for segmenting large evidence grids into manageable pieces. In this project we will evaluate the maturity of these algorithms, developed for research programs at Carnegie Mellon, and incorporate them into our RASM architecture, thus providing portable and reliable localization for a variety of vehicle platforms and sensors. Mission constraints will vary broadly, so our SLAM components will be able to merge readings from various suites of sensors that may be found on planetary rovers.



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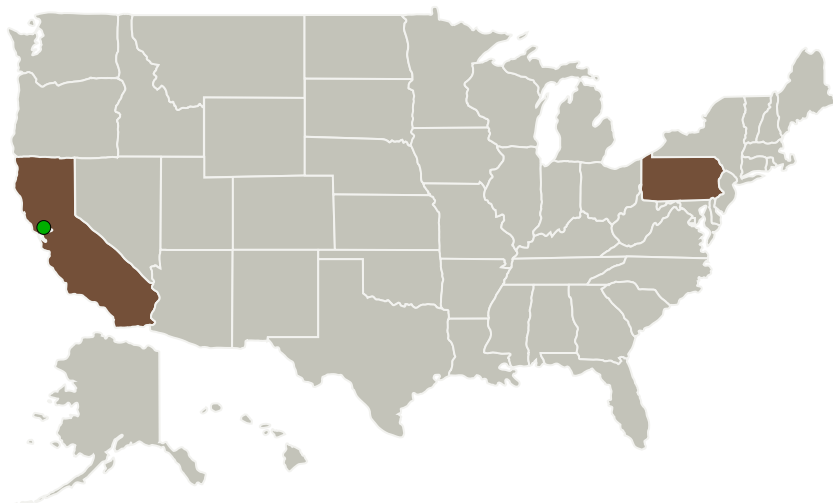
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## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Protoinnovations, LLC	Lead Organization	Industry	Pittsburgh, Pennsylvania
● Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California
Carnegie Mellon University	Supporting Organization	Academia	Pittsburgh, Pennsylvania

Primary U.S. Work Locations	
California	Pennsylvania

## Project Transitions

**March 2011:** Project Start**February 2012:** Closed out

### Closeout Documentation:

- Final Summary Chart(<https://techport.nasa.gov/file/138503>)

## Organizational Responsibility

### Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

### Lead Organization:

Protoinnovations, LLC

### Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

### Program Director:

Jason L Kessler

### Program Manager:

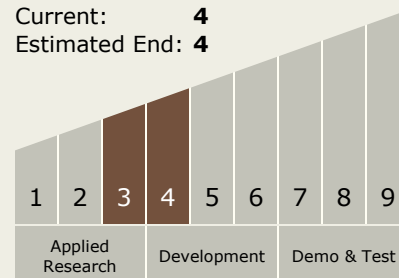
Carlos Torrez

### Principal Investigator:

David Wettergreen

## Technology Maturity (TRL)

Start: **3**  
 Current: **4**  
 Estimated End: **4**



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## Technology Areas

### Primary:

- TX04 Robotic Systems
  - └ TX04.2 Mobility
    - └ TX04.2.5 Robot Navigation and Path Planning

## Target Destinations

The Moon, Mars, Outside the Solar System, The Sun, Earth, Others Inside the Solar System